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An Automated Method of Facilitating Analysis of Voice Communications

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ABSTRACT

DSTO has historically gathered voice communications data for analysis. Preparing this data for analysis is very time intensive and in many cases cannot be undertaken due to resource constraints. This paper describes a simple computer tool to automatically log and compress live communications activity or previously tape recorded analogue information. The tool presents this information in a form ready for immediate computer based analysis.

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An Automated Method of Facilitating Analysis of Voice Communications

Executive Summary

This paper describes the selection and use of a simple software tool for logging and recording communications audio information for computer based communications research and analysis.

This requirement arose from a need to analyse communications from the Headline 2000 experiment. It was known that digital recordings of communications audio had been made but that these required manual log generation and analysis. This was a manual, time intensive process. Due to higher priority tasks this effort could not be committed. A computer-based tool would overcome much of the problem with manual logging.

A number of parameters were established to guide the selection of a suitable tool. These were:

- Duration of communication (length)
- Number of communications in a given time period (channel occupancy)
- Maximum period between communications (channel free)
- Communication density as a function of time (peak usage)

A further desirable feature was the need for the software to be able to operate on a variety of platforms using older processors. Such a tool was eventually found.

The tool selected and used for the purpose of logging and recording the Headline 2000 audio communications is a freeware package "ScanRec". This tool was produced for the radio scanning enthusiast community and meets the parameters identified by the authors for the purposes of logging communications audio in an analysable form. This tool produces both text event log files and compressed audio files of the .WAV type.

Contents

1. Introduction

Network Architectures Group of Information Networks Division of DSTO in developing a sound architectural base for future battlespace (land) communications has a need for statistical information on voice communications traffic. Land Operations Division as a matter of routine has collected large volumes of real time analogue recordings of voice transmissions over wireless networks used by tactical units. Analysis of this large volume of data has been precluded due to the manpower intensive task of listening to the real-time recordings of the communications networks and transcribing the data into a readily analysable form.

The Headline (HE) series of experiments are CPX level experiments that include the emulation of operational wireless voice communications between the brigade headquarters and sub-ordinate battlegroups. Communications (now Information Networks) Division staff have been involved in the analysis of formal traffic during the Headline 2000 experiment [1]. The transmissions over the voice wireless links had been tape recorded by the technical staff of the Land Operations Division (LOD) of DSTO, but have not been transcribed into an analysable form. One of the tape recordings is known to have been briefly analysed manually. Having need of the evaluation of the voice communications to explore communications issues for research, the authors investigated possible methods of automated collection of the information in a form suitable for computer-based analysis.

2. Tool Requirements

The authors began by first determining what parameters of voice communications needed to be studied, then the search for a tool was carried out. For the architecture task the primary parameters required were:

- Duration of communication (length)
- Number of communications in a given time period (channel occupancy)
- Maximum period between communications (channel free)
- Communication density as a function of time (peak usage)

A further desirable requirement was the ability to operate on a variety of computer platforms, and not to require the full processing power of the latest generation of processors. This would allow use of the tool on many portable and older machines.

In addition, it was necessary to be able to access the communication content to be able to determine, if possible, the communication links to facilitate information exchange analysis as well as traffic flow analysis. That is, who was talking to whom and about

what. This information assists in establishing the traffic between certain entities or nodes and the types of messages being passed.

Periods of silence or inactivity on a net could be quite lengthy and wasteful of an analyst's or transcriber's time. Thus a requirement was to obviate the need to monitor such periods of silence on the tape recordings, but without missing any communications that may occur.

From these requirements the software tool would need to be simple, produce the required outputs, be able to simply interface to a variety of systems and equipment, require a minimum of control signals (preferably none) and to compress the activity of the wireless medium by removing periods of silence without compromising the collection of communications information.

3. Tool Search

3.1 Categories

The initial concept was that some of the tools used for digitally recording music might be suitable for the task. A search of the Internet was carried out for appropriate shareware or freeware. A number of tools were obtained, but when tested they were found to be not fully suitable. While they were more than adequate for the purpose of recording the audio content of the communication, they did not produce the other necessary log files of the data. Further, because most music recorders use a fairly high sampling rate (for the required quality) the audio files produced were unnecessarily large for the purpose.

One of the authors with a background in radio communications including Amateur Radio, began searching for other tools as used by the Amateur Radio community, scanner enthusiasts, and CB radio users. As a result, the next category searched by the authors was computer based control software for radio equipment. Much of this software has the capability of logging signals in various forms. A number of packages were examined, however, most were not suitable for the required task. In general, they required hardware control signals in addition to the audio communications component. These control signals are not part of recordings collected.

The final category searched was scanner receiver logging software, as used by radio scanner enthusiasts. Several tools were found that appeared to be suitable for the task. During testing, a freeware tool called "ScanRec"[2] appeared to fully meet the authors' requirements.

All of the tools required at least the presence of a "SoundBlaster" compatible sound card installed in the logging computer to function correctly.

3.2 Tool Evaluation

Seven tools were evaluated for the required task. These were:

1. Looprecorder201
2. Looprecorder201pro
3. Mediajukebox21
4. AOR8000 Remote control V1.4
5. AR3000 remote control centre
6. Voxrecorder
7. ScanRec

3.2.1 Looprecorder201 (both versions)

These tools were not suitable as they were intended for music recording and the audio files produced were large. Further, they did not produce log files suitable for the required task.

3.2.2 Mediajukebox21

Constraints similar to those for the Looprecorder tools as described previously apply to this tool.

3.2.3 AOR8000 Remote control V1.4

This control package is targeted at a specific piece of equipment, the AOR AR8000 scanning receiver. Although it allowed for good control of the equipment and supposedly has the capability of producing both log files and audio files, during evaluation it was unable to generate audio files. It also required a control interface as well as the audio signal input. It was not able to accept and log an input independently from controlling the equipment. That is, it could not accept a tape recorded playback of communications.

3.2.4 AR3000 remote control centre

Similar comments as stated regarding the AOR8000 remote control above apply to this control software.

3.2.5 Voxrecorder

This tool had most of the attributes required for the task. A snapshot of the user interface is shown in Figure 1. The drawback with this software was that the audio sampling rate was fixed at approx 22KHz, consequently the audio files were considered to be over-large for the task requirements.

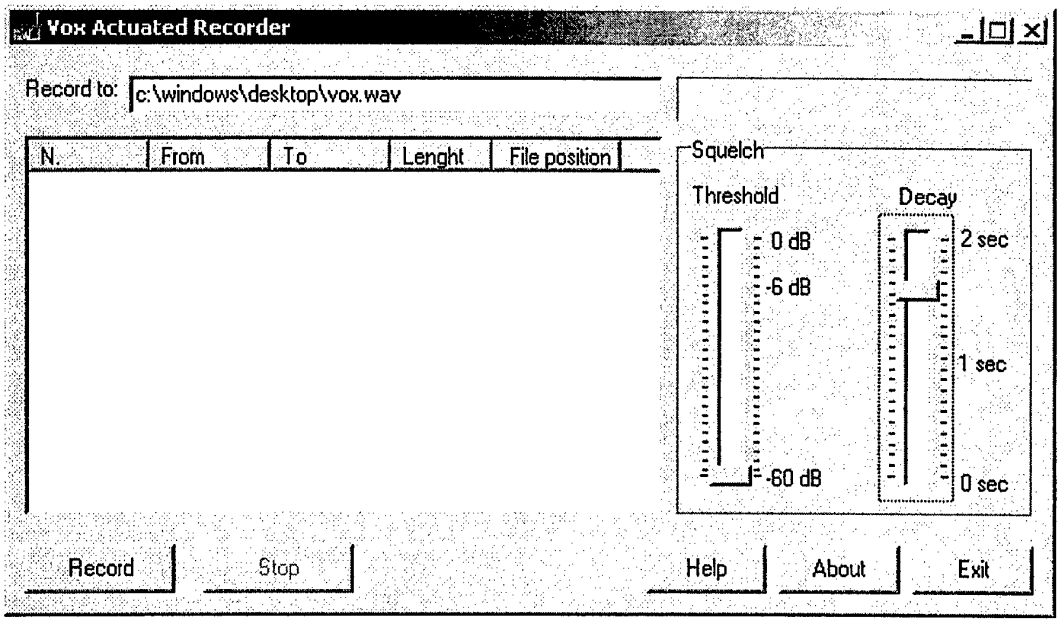


Figure 1 – Voxrecorder user window

3.2.6 ScanRec

ScanRec appeared to have all of the necessary attributes for the task. It required no inputs other than the audio, and had controls to set the recording threshold and recording delay. It also allowed the sampling rate to be set to that appropriate for the particular requirement. The user interface window is shown in Figure 2.

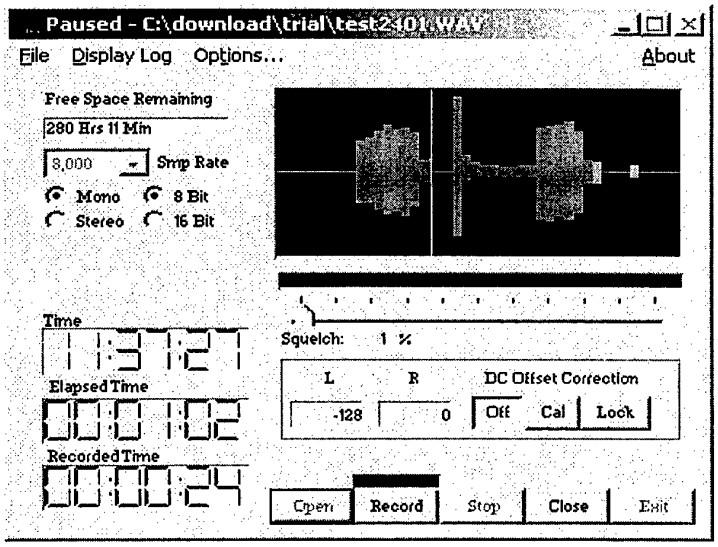


Figure 2. – ScanRec user interface window

3.2.7 Evaluation Result

After evaluating the software tools detailed above, the authors selected ScanRec ([2] as the tool most suitable for the required task.

4. Use of ScanRec Tool

A period of testing and familiarisation with the ScanRec tool was carried out to determine the best settings for the logging functions required. In using the tool three settings are most important to obtain valid results:

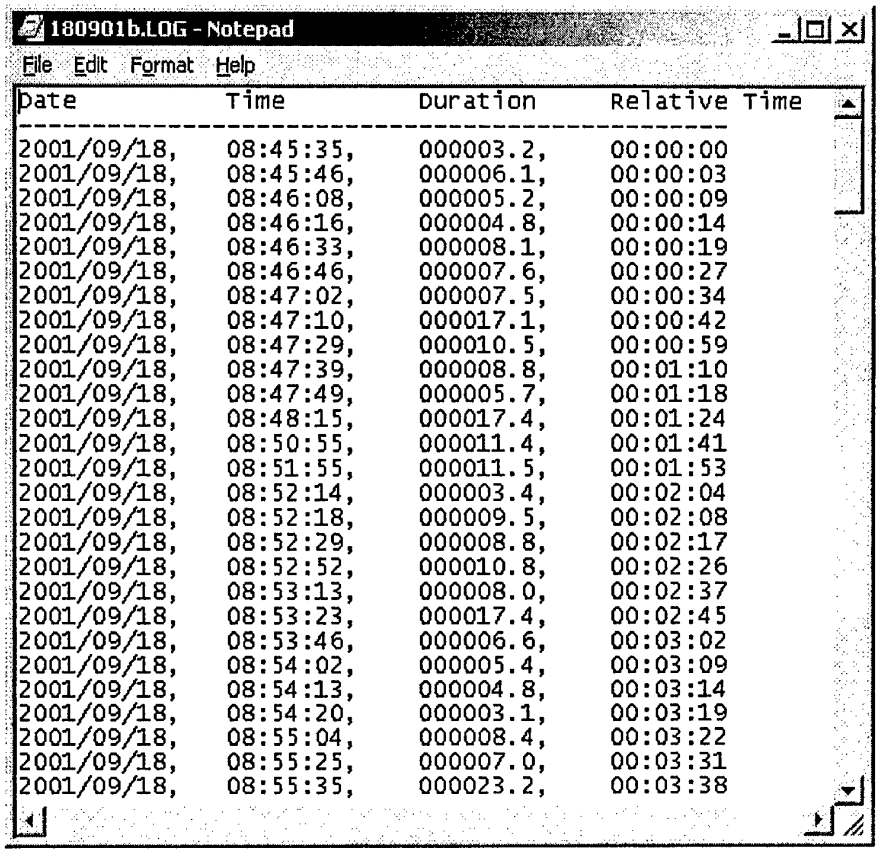
- Sampling Rate.
- Squelch level.
- Squelch delay

(See Appendix A for further information about setting up the tool.)

One of the advantages in the use of this type of tool is that once the transmission information is logged and recorded, all further work can be carried out at a computer without the need for additional equipment to play back audio tape recordings. As the generated files are normal computer files they can be stored on conventional computer media, for example such as CD ROMs (Compact Disc Read Only Memory).

4.1 Sampling Rate

The sampling rate determines the quality of the recorded audio signal and the size of the logged audio file. The audio is recorded as a 'Windows' compatible wave (.WAV) file. This is configured at the start of a recording session. For communications quality voice recording, the lowest sampling rate (8KHz) monophonic recording is adequate and still allows sufficient quality for voice recognition. When a file name is entered, two files are created. One of these is the .WAV type file to record the audio component, the other is a .LOG type text file that records the relevant statistical information as text in table form.



180901b.LOG - Notepad

File Edit Format Help

Date	Time	Duration	Relative Time
2001/09/18,	08:45:35,	000003.2,	00:00:00
2001/09/18,	08:45:46,	000006.1,	00:00:03
2001/09/18,	08:46:08,	000005.2,	00:00:09
2001/09/18,	08:46:16,	000004.8,	00:00:14
2001/09/18,	08:46:33,	000008.1,	00:00:19
2001/09/18,	08:46:46,	000007.6,	00:00:27
2001/09/18,	08:47:02,	000007.5,	00:00:34
2001/09/18,	08:47:10,	000017.1,	00:00:42
2001/09/18,	08:47:29,	000010.5,	00:00:59
2001/09/18,	08:47:39,	000008.8,	00:01:10
2001/09/18,	08:47:49,	000005.7,	00:01:18
2001/09/18,	08:48:15,	000017.4,	00:01:24
2001/09/18,	08:50:55,	000011.4,	00:01:41
2001/09/18,	08:51:55,	000011.5,	00:01:53
2001/09/18,	08:52:14,	000003.4,	00:02:04
2001/09/18,	08:52:18,	000009.5,	00:02:08
2001/09/18,	08:52:29,	000008.8,	00:02:17
2001/09/18,	08:52:52,	000010.8,	00:02:26
2001/09/18,	08:53:13,	000008.0,	00:02:37
2001/09/18,	08:53:23,	000017.4,	00:02:45
2001/09/18,	08:53:46,	000006.6,	00:03:02
2001/09/18,	08:54:02,	000005.4,	00:03:09
2001/09/18,	08:54:13,	000004.8,	00:03:14
2001/09/18,	08:54:20,	000003.1,	00:03:19
2001/09/18,	08:55:04,	000008.4,	00:03:22
2001/09/18,	08:55:25,	000007.0,	00:03:31
2001/09/18,	08:55:35,	000023.2,	00:03:38

Figure 3 – Sample of .LOG file

4.1.1 The .LOG File Description.

This file is a text file of four columns as shown in Figure 3.

- 'DATE' is self explanatory and is automatically obtained from the computer date setting. When a tape recording is being logged, the computer time can be adjusted to match the tape time thus providing proper time correlation in the .LOG file.
- The 'TIME' column shows the start time of each recorded segment while the
- 'DURATION' column shows the length of that segment. The time is automatically derived from the computer time setting.
- The 'RELATIVE TIME' column shows the time relative to the start of the audio recording as compressed by ScanRec. Because no silence is normally recorded, this time is necessary to locate particular segments.

In the example used for illustration in Figure 3, the total period of recording/logging was just under one hour. However the total time of the audio signal recorded was only

17 minutes and 59 seconds. The 'RELATIVE TIME' column shown is the time relative to the start of this 17 min 59 sec period.

While the correct settings as described in Appendix A will enable most distinct transmissions to be separated and logged correctly, there will inevitably be some that will not be properly logged due to either a lengthy pause with insufficient background noise, or by a reply occurring too quickly to be distinguished. Normally such occurrences will statistically average out over a reasonably long period of monitoring. However, the .LOG file can be subsequently edited in conjunction with a review of the .WAV audio component file.

4.2 Ancillary Equipment

The above discussion covers the use of the ScanRec tool for transferring a single voice channel recording to the computer files. LOD commonly uses multi-track tape recorders and to have these audio tracks compressed concurrently by ScanRec requires the use of a corresponding number of computers scaled one per track. These computers need to have synchronised clocks as well as the synchronisation of the start of recording to achieve proper time correlation. This requires some skill on the part of the operator but is relatively easy to achieve with a little practice.

5. Sample Results

The following Table 1 is an example of the results obtained by copying and pasting the recorded .LOG file into a spreadsheet. These were obtained with a very small amount of manual effort compared to previous attempts to log and analyse the communications information.

Table 1 – Sample results

Total Time	1:15:55	H:M:S
Time used	590.4	09:50.4
No. TX's	99	
Ave Length	5.96	Secs
Max length	23.2	Secs
Min Length	0.3	Secs
Max Gap	15:15	Secs
Min Gap	0:01	Secs
Occupancy	7.72%	
Std Dev	5.53	

The information in Table 2 was obtained by listening to the .WAV file and manually identifying the callsigns. This was a much less onerous task because the long periods of silence had been removed. The task was facilitated by the functionality and ease of use of the computer tools available to play back .WAV files.

Table 2 – Transmission Identification

Transmissions Identified	
Tango Zero	20
Tango One	13
Locon	2
Tango ZeroAlpha	10
Unidentified Transmissions	39

6. Application

ScanRec can be used to record directly from the audio of a radio receiver, however this use does not provide the archival back-up of source material. The use of ScanRec to transcribe and compress the duration of the recording could enable analysis of voice transmissions to proceed on the completion of an analogue tape. However, the initial transcription would occur in tape time (currently one hour 45 minutes), precluding the commencement of any manual analysis until this compression was completed. In an experiment scenario, analysis could be occurring at least this time behind events. While possibly precluding participation in hot wash-ups of the immediately preceding session this does allow follow up of issues from one session at the end of the next session.

Currently ScanRec is being used to facilitate the analysis of Headline 00 recordings of voice radio transmissions.

7. Conclusions

The use of the ScanRec tool for facilitating the analysis of tape recordings of radio transmissions in clear voice is most applicable. Its use allows analysis of data to proceed very soon after it was collected. Preliminary results of analysis could be presented and follow-up of issues identified during the analysis process could occur at a 'one session' delay behind the events analysed. Any clarifications or questions raised by the analysis could be addressed while the events were still fresh in the minds of the participants in the activity being analysed.

There is further scope for automated analysis to be expanded by applying voice and speaker recognition tools to the .WAV file generated by this tool. This may allow callsigns and speakers to automatically identified and linked to the .LOG file, thus allowing for more detailed automated statistical generation.

8. Recommendations

The three most significant recommendations that can be made regarding ScanRec are:

- ScanRec should be used as an analysis tool until a better tool is acquired.
- It should be used log data for 'hot' analysis during experiments and field trials.
- It should be used to compress data on audio tape recordings held from previous field trials and experiments.

9. References

[1] Clark, Philip Dickinson, Rowland; "Headline 2000 Post Experiment Report CD Aspects"; DSTO-CR-0205, AR-011-956, DSTO, Adelaide, July 2001.

[2] Jacobs, Dave; http://www.davee.com/scanrec/

Appendix A: Setting up the ScanRec Tool

A.1. Setting the Sampling Rate.

Figure A1 shows where the sampling rate is selected after a file is opened for recording.

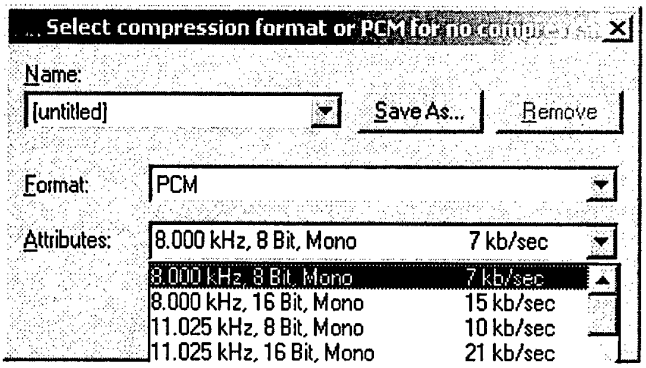


Figure A1. – Selecting the Sampling Rate

When the sampling rate has been selected by pressing 'OK', the tool is ready to record, however the Squelch level and Squelch delay should be checked and set before starting the recording.

A.2. Squelch Setting

A.2.1 Squelch Level.

The setting of this level is very important in obtaining good statistics.

When monitoring a normal radio conversation, the start and finish of an 'over'[1] can be determined by the operation of the radio receiver. However, when monitoring only the audio content, some other means must be used to determine the start and finish of the 'over'. When doing this, there can be a problem if the speaker pauses in their speech, but is still transmitting. That is, they have not finished the 'over'. A further problem that occurs is when the receiving station responds very quickly so that the break between the 'over' of the first station and the start of transmission of the second is less than the ability of ScanRec to detect.

[1] An 'over' is each single transmission from one of the stations in a radio conversation. For example, station one calls station two. This is one 'over'. Station two responds, this is another 'over'. Normally a radio conversation consists of a number of 'overs' from the participating stations to complete the communication.

To ameliorate this situation, the Squelch level and Squelch delay settings must be correctly adjusted.

The problem of the pause in speech can be largely overcome by taking into account the following. Firstly, when no transmissions occur, there will normally be a zero level (or very close to it) of background noise. Secondly, there is normally some small amount of background noise, even without speech present, whenever a transmission is occurring. The Squelch delay setting is also used to assist in determining whether a pause in speech is the end of an 'over' or not.

Setting the Squelch level to the minimum (1%) will most often detect between the zero level of noise and the small amount occurring whenever there is a transmission. (This may need to be adjusted if the audio tape has a permanent 'noisy' background.)

A.2.2 Squelch Delay.

The problem of determining the start of the next transmission and the finish of the previous 'over' is carried out by a combination of the Squelch level and Squelch delay settings. With the level set to 1%, the Squelch delay (see Figure A2) should be adjusted to between 300ms and 500ms. This setting determines how long a recording will continue after the audio signal falls below the set threshold. Normally the 300ms setting is sufficient to enable proper detection of the end of an 'over', even if there are some pauses in the speech. Shorter periods may be experimented with, however if the setting is too long the break between 'overs' may not be detected and the log file may not correctly log the transmission statistics.

A.3. Recording.

The recording is started by clicking on the 'RECORD' button.

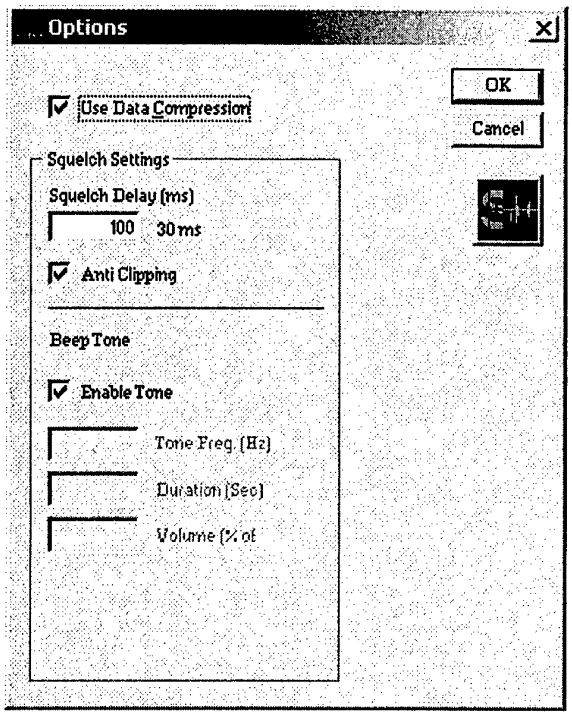


Figure A2 – Options screen showing Squelch delay window.

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